HEATER PIPE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a heater pipe for leading engine cooling fluid to at least a heater for heating air-conditioning air.

2. Description of the Related Art

The heater functions to heat the air-conditioning air supplied into the passenger compartment of an automotive vehicle (Japanese Unexamined Patent Publication No. 9-20128). The engine cooling fluid (hereinafter sometimes referred to as "the hot water") is led from the engine to the heater through the heater pipe.

Fig. 12 shows a layout of heater pipes. As shown in Fig. 12, heater pipes 100a, 100b are interposed between an engine 101, a front heater 102 and a rear heater 103. The heater pipes 100a are connected to each other by a corresponding one of heater hoses 104, and so are the heater pipes 100b.

The heater pipes 100a, 100b circulate hot water, heated by cooling the engine 101, through the front heater 102 and the rear heater 103. Specifically, the hot water that has flowed into the front heater 102 and the rear heater 103 from the engine 101 through the heater pipes 100a heats the air-conditioning air. The hot water deprived of heat by the air-conditioning air flows out from the front heater 102 and the rear heater 103 through the heater pipes 100b and returns to the engine 101.

Conventionally, the heater pipes 100a on the inflow side of the heaters and the heater pipes 100b on the outflow side of the heaters are arranged independently of each other. For this reason, the degree of freedom of the piping route is small. Also, the

heater pipes 100a, 100b occupy so large an installation space as to limit the installation space for other members. In other words, the layout freedom is small.

Also, the heater pipes 100a, 100b and the heater hoses 104 are connected to each other by a spring-type hose clip. Therefore, a great number of parts are required, and the assembly work is complicated.

Further, the heater pipes 100a on the inflow side of each heater are exposed, and therefore the heat energy loss of the hot water is great in the heater pipes 100a. Specifically, the hot water is considerably reduced in temperature before flowing into the front heater 102 and the rear heater 103. This tendency is conspicuous especially for the long part of the heater pipes 100a leading to the rear heater 103. In some types of vehicles, the heater pipes 100a are arranged on the vehicle bottom, and exposed outside of the vehicle body. This arrangement, coupled with the cooling effect of the air flow to which the vehicle is exposed while running, considerably reduces the temperature of the hot water in the heater pipes 100a.

A method conceivable to suppress the temperature drop of the hot water is to cover the heater pipes 100a with a heat insulating jacket. This configuration, however, increases the already great number of parts even more, and the assembly work becomes more complicated.

SUMMARY OF THE INVENTION

The heater pipe according to this invention has been developed in view of the problems described above. Accordingly, an object of this invention is to provide a heater pipe having a high layout freedom and capable of suppressing the temperature reduction of the hot water on the inflow side thereof. Another object of this invention is to provide a heater pipe comprising joints having a high layout freedom. Still another object of the invention is to provide a heater pipe having a

superior assembly workability.

In order to solve the problems described above, according to one aspect of the invention, there is provided a heater pipe interposed between an engine and at least a heater for circulating the engine cooling fluid in the heater, comprising an inner pipe for supplying the engine cooling fluid into the heater, and an outer pipe arranged on the outer periphery of the inner pipe for discharging from the heater the engine cooling fluid that has heated the air-conditioning air in the heater.

Specifically, the heater pipe according to the invention has a double-pipe configuration. The hot water on the inflow side of the heater flows in the inner pipe, and the inner pipe corresponds to the heater pipes 100a shown in Fig. 12. The hot water on the outflow side of the heater, on the other hand, flows in the outer pipe, and the outer pipe corresponds to the heater pipes 100b shown in Fig. 12.

The temperature of the hot water flowing in the outer pipe is higher than the atmospheric air temperature. Therefore, the temperature difference between the hot water flowing in the outer pipe and the hot water flowing in the inner pipe is smaller than the difference between the atmospheric air temperature and the temperature of the hot water flowing in the inner pipe. With the heater pipe according to the invention, therefore, the energy loss of the hot water on the inflow side of the heater is small as compared with a case in which the heater pipes 100a on the inflow side of the heater and the heater pipes 100b on the outflow side of the heaters are arranged independently of each other (Fig. 12). In other words, the temperature of the hot water on the inflow side of the heater is reduced to a lesser degree.

Also, with the heater pipe according to this invention, a smaller installation space is required than

in the case where the heater pipes 100a on the inflow side of the heater and the heater pipe 100b on the outflow side of the heaters are arranged independently of each other (Fig. 12). As a result, the installation space of the other members is limited to a lesser degree. In other words, the degree of freedom of the piping route, i.e. the layout freedom is high.

Preferably, the inner pipe and the outer pipe are arranged substantially coaxially. With this configuration, the effect of heat insulation of the inner pipe by the outer pipe is substantially uniform over the whole circumference of the inner pipe.

Also, each joint of the heater pipe according to the invention includes an inner peripheral chamber, an outer peripheral chamber arranged on the outer periphery of the inner peripheral chamber, a first branch joint portion communicating with the inner peripheral chamber, and a second branch joint portion communicating with the outer peripheral chamber and arranged independently of the first branch joint portion.

Specifically, each joint of the heater pipe according to this invention has an inner peripheral chamber, an outer peripheral chamber, a first branch joint portion and a second branch joint portion. The inner peripheral chamber communicates with the first branch joint portion. The outer peripheral chamber communicates with the second branch joint portion. The first branch joint portion and the second branch joint portion are independent of each other.

With the joint of the heater pipe according to the invention, the inner and outer peripheral chambers can branch and connect to other members. Also, the installation space is smaller than in the case of the joints dedicated to the fluid flowing in the inner peripheral chamber and the fluid flowing in the outer peripheral chamber, respectively. This leads to a higher layout freedom.

Preferably, the inner peripheral chamber and the first branch joint portion are arranged substantially linearly, while the outer peripheral chamber and the second branch joint portion are arranged with an intersection angle of more than 90 degrees between the axes thereof.

Specifically, in this configuration, the inner peripheral chamber and the first branch joint portion are arranged substantially linearly. At the same time, the outer peripheral chamber and the second branch joint portion are arranged with an intersection angle of more than 90 degrees between the axis of the outer peripheral chamber and the axis of the second branch joint portion.

The inner peripheral chamber and the first branch joint portion are arranged substantially linearly in order to minimize the flow path resistance between the inner peripheral chamber and the first branch joint portion. Also, the intersection angle between the axis of the outer peripheral chamber and the axis of the second branch joint portion is set to more than 90 degrees because an intersection angle of not more than 90 degrees between the axis of the outer peripheral chamber and the axis of the second branch joint portion would increase the flow path resistance between the outer peripheral chamber and the second branch joint portion. With this configuration, the flow path resistance between the inner peripheral chamber and the first branch joint portion is very small. The flow path resistance between the outer peripheral chamber and the second branch joint portion is also comparatively small.

Preferably, the first branch joint portion and the second branch joint portion are arranged substantially in parallel to the direction of the joint axis. This configuration eliminates the need of the projection margin along the radial direction of the first branch joint portion and the second branch joint portion and, therefore, a compact structure is realized. Also, the

coincidence between the direction of the joint axis and the longitudinal direction of the vehicle makes it possible to install the joints with the air flow kept out of contact with the first branch joint portion and the second branch joint portion while the vehicle is running. As a result, the temperature reduction of the fluid due to the air flow is suppressed.

According to another aspect of the invention, there is provided a heater pipe comprising:

a pipe unit including an inner pipe for supplying the engine cooling fluid into a heater, and an outer pipe arranged on the outer periphery of the inner pipe for discharging from the heater the engine cooling fluid having heated the air-conditioning air in the heater;

a joint unit including an inner peripheral chamber connected to the inner pipe, an outer peripheral chamber arranged on the outer periphery of the inner peripheral chamber and connected to the outer pipe, a first branch joint portion communicating with the inner peripheral chamber, and a second branch joint portion communicating with the outer peripheral chamber and arranged independently of the first branch joint portion;

an inner seal unit arranged between the inner pipe and the inner peripheral chamber; and

an outer seal unit arranged between the outer pipe and the outer peripheral chamber;

wherein the pipe unit includes a pipe-side engaging portion and the joint unit includes a joint-side engaging portion; and

wherein the pipe unit and the joint unit are connected by one touch by the engagement between the pipe-side engaging portion and the joint-side engaging portion.

Specifically, the heater pipe according to this invention comprises the pipe unit, the joint unit, the inner peripheral seal unit and the outer peripheral seal unit. The pipe unit and the joint unit can be connected

to each other by one touch. Specifically, the pipe-side engaging portion is arranged in the pipe unit, and the joint unit has the joint-side engaging portion arranged therein. By engaging these two engaging portions with each other, the pipe unit and the joint unit can be connected to each other with one action. At the same time, the sealability is secured by the inner peripheral seal unit between the inner pipe and the inner peripheral chamber. Similarly, the sealability is secured by the outer peripheral seal unit between the outer pipe and the outer peripheral chamber.

With the heater pipe according to the invention, the pipe unit and the joint unit can be assembled easily. In the case where the assembly work is conducted using the conventional spring-type hose clip, the pipe unit and the joint unit assembled may be separated from each other or the sealability between the pipe unit and the joint unit may be reduced by an assembly error peculiar to individual workers. With the heater pipe according to the invention, by contrast, the pipe unit and the joint unit are connected to each other only by the engaging force between the pipe-side engaging portion and the joint-side engaging portion. As a result, an assembly error peculiar to individual workers is less likely to occur. Specifically, a strong connecting force can be secured regardless of the skill difference among workers. Therefore, the heater pipe according to the invention is advantageously used in the case where a multiplicity of assembly points are involved.

Preferably, the inner peripheral chamber and the outer peripheral chamber are partitioned by a partitioning wall integrated with the joint unit. The partitioning wall integrated with the joint unit is stronger. With this configuration, therefore, the inner peripheral chamber and the outer peripheral chamber can be positively insulated from each other. Also, as compared with a case in which the partitioning wall is

separated from the joint unit, the number of required parts is reduced.

Preferably, the inner peripheral chamber and the outer peripheral chamber are partitioned from each other by the inner pipe. This configuration can insulate the inner peripheral chamber and the outer peripheral chamber from each other without any partitioning wall configured as described above. Thus, the internal shape of the joint is simplified. Therefore, in the case where the joint unit is made by resin molding, for example, the mold cost is reduced for a lower production cost of the joint unit. Also, the simplistic internal shape of the joint facilitates the release of the mold.

Preferably, at least one of the inner peripheral seal unit and the outer peripheral seal unit is arranged in a position where the cross sectional area of the flow path of the engine cooling fluid is not reduced. With this configuration, the flow of the engine cooling fluid is less likely to be hampered by at least one of the outer peripheral seal unit and the inner peripheral seal unit. For this reason, the flow rate of the hot water required to heat the air-conditioning air can be secured with comparative ease.

Preferably, at least one of the inner peripheral seal unit and the outer peripheral seal unit is held between the pipe unit and the joint unit in axial direction by the engaging force of the pipe-side engaging portion and the joint-side engaging portion.

Specifically, in this configuration, the engaging force of the pipe-side engaging portion and the joint-side engaging portion is utilized as a sealing force of at least one of the inner peripheral seal unit and the outer peripheral seal unit. With this configuration, as at least one of the inner peripheral seal unit and the outer peripheral seal unit is held axially between the pipe unit and the joint unit, the shape in the neighborhood of the seal units is simplified compared

with a case in which at least one of the inner peripheral seal unit and the outer peripheral seal unit is held in radial direction between the pipe unit and the joint unit. Specifically, the grooves for arranging the inner peripheral seal unit and the outer peripheral seal unit are not required to be formed in the joint unit, thereby facilitating the shaping of the joint unit. This, in turn, reduces the mold cost in the case where the joint unit is made of resin molding and, for example, reducing the production cost of the joint unit. As the grooves are eliminated, the shaping of the joint unit is simplified, and the mold is released easily.

Preferably, the joint-side engaging portion is formed integrally with the joint unit. With this configuration, compared with a case in which the joint-side engaging portion is formed independently of the joint unit, both the number of parts and the number of steps required are reduced.

Preferably, the joint-side engaging portion and the pipe-side engaging portion are arranged in such a position that the reduction in the sealing force of the outer peripheral seal unit due to the engagement between the two engaging portions can be suppressed. Once the joint-side engaging portion and the pipe-side engaging portion engage with each other, the part in the neighborhood of the two engaging portions may be deformed under the tension caused by the two engaging portions. This deformation may reduce the sealing force of the outer peripheral seal unit. The joint-side engaging portion and the pipe-side engaging portion according to the configuration described above, in contrast, are arranged in such a position as to suppress the reduction in the sealing force of the outer peripheral seal unit. As a result, the sealing force of the outer peripheral seal unit is not liable to be decreased by the engagement between the two engaging portions. Thus, the hot water is less likely to leak out.

Preferably, the joint-side engaging portion is an engaging hook arranged on the outer peripheral surface of the outer wall surrounding the outer peripheral chamber, and the pipe-side engaging portion is an annular rib arranged along the outer peripheral surface of the outer pipe, so that the pipe unit and the joint unit are adapted to be connected to each other by one touch by the engaging hook engaging the annular rib.

Specifically, with this configuration, the pipe unit and the joint unit are connected to each other, by one action, as the result of the engaging hook engaging the annular rib. This configuration makes it possible to connect the pipe unit and the joint unit to each other by one action with a comparatively simple structure. Also, the annular rib is arranged over the entire circumference of the outer peripheral surface of the outer pipe, and therefore the engaging hook can be engaged freely along the peripheral direction of the annular rib. In other words, the joint unit can be connected by being twisted at an arbitrary angle along the periphery of the pipe unit. As a result, the first branch joint portion and the second branch joint portion of the joint unit can be arranged at a desired angle. This leads to a higher freedom of the piping route, and hence a higher layout freedom.

Preferably, at least one of the members making up the connecting portion between the outer pipe and the outer peripheral chamber and the connecting portion between the inner pipe and the inner peripheral chamber is formed with a tapered portion to facilitate the relative positioning of the heating pipe and the joint connected. Of the members constituting the connecting portions, an inserting member is formed with a tapered portion narrowed progressively toward a receiving member. The receiving member, on the other hand, is formed with a tapered portion expanding toward the inserting member. This configuration facilitates the relative positioning

of the joint unit and the pipe unit, and thus simplifies the assembly work.

The present invention may be more fully understood from the description of preferred embodiments of the invention, as set forth below, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a layout of a heater pipe (pipe unit) and joints (joint unit) according to a first embodiment of the invention.

Fig. 2 is an axial sectional view of the connecting portion between the rear heater-side end portion of the heater pipe and a joint according to the first embodiment of the invention.

Fig. 3 is a perspective view of the connecting portion between the rear heater-side end portion of the heater pipe and a joint according to the first embodiment of the invention.

Fig. 4 is an exploded perspective view of the connecting portion between the rear heater-side end portion of the heater pipe and a joint according to the first embodiment of the invention.

Fig. 5 shows a layout of a die used for molding the joint according to the first embodiment of the invention.

Fig. 6 is an axial sectional view of the connecting portion between the rear heater-side end portion of the heater pipe (pipe unit) and a joint (joint unit) according to a second embodiment of the invention.

Fig. 7 is an axial sectional view of the connecting portion between the rear heater-side end portion of the heater pipe (pipe unit) and a joint (joint unit) according to a third embodiment of the invention.

Fig. 8 shows a layout of a heater pipe (pipe unit) and joints (joint unit) according to a fourth embodiment of the invention.

Fig. 9 is an axial sectional view of the connecting portion between the rear heater-side end portion of the

heater pipe (pipe unit) and a joint (joint unit) according to a fifth embodiment of the invention.

Fig. 10 is an axially exploded sectional view of the connecting portion between the rear heater-side end portion of the heater pipe and a joint according to the fifth embodiment of the invention.

Fig. 11 shows a layout of a die used for molding a joint according to the fifth embodiment of the invention.

Fig. 12 shows a layout of the conventional heater pipes.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The heater pipe, joints and the connecting structure between the heater pipe (pipe unit) and the joints (joint unit) embodying the invention are explained below.

(First embodiment)

First, a configuration of the heater pipe, the joints and the connecting structure between the heater pipe (pipe unit) and the joints (joint unit) according to this embodiment is explained. Fig. 1 shows a layout of a heater pipe (pipe unit) and joints (joint unit) according to this embodiment. As shown in Fig. 1, a heater hose 3a, an inflow pipe 4 and a heater hose 3b are arranged in that order as viewed from an engine 90 toward a front heater 91 between the engine 90 and the front heater 91. On the other hand, a heater hose 3d, an outflow pipe 5 and a heater hose 3c are arranged in that order as viewed from the front heater 91 toward the engine 90.

Between the engine 90 and a rear heater 92, on the other hand, the heater hose 3a, the inflow pipe 4, a heater hose 3f, a joint 2a, a heater pipe 1, a joint 2b and a heater hose 3g are arranged in that order as viewed from the engine 90 toward the rear heater 92 between the engine 90 and the rear heater 92. As viewed from the rear heater 92 toward the engine 90, on the other hand, a heater hose 3h, the joint 2b, the heater pipe 1, the joint 2a, a heater hose 3e, the outflow pipe 5 and the heater hose 3c are arranged in that order. Specifically,

the heater pipe 1 and the joints 2a, 2b are interposed between the engine 90 and the rear heater 92. The inflow pipe 4 and the outflow pipe 5 are both an extrusion-molded aluminum product. The heater hoses 3a, 3b, 3c, 3d, 3e, 3f, 3g and 3h are all made of rubber reinforced with PA (polyamide) fibers.

Fig. 2 is an axial sectional view showing the connecting portion between the rear heater-side end portion of the heater pipe (pipe unit) 1 and the joint 2b (joint unit). Fig. 3 is a perspective view showing the connecting portion between the rear heater-side end portion of the heater pipe (pipe unit) 1 and the joint 2b (joint unit).

As shown in Fig. 2, the heater pipe 1 includes an inner pipe 10 and an outer pipe 11. The inner pipe 10 and the outer pipe 11 are both in the shape of a long cylinder. The inner pipe 10 and the outer pipe 11 are an extrusion-molded aluminum product, and are arranged substantially coaxially. An inner peripheral annular groove 60 is formed in the outer peripheral surface at the end portion of the inner pipe 10. An inner peripheral rubber seal ring 60 is arranged in the inner peripheral annular groove 12. The inner seal ring 60 is included in an inner peripheral seal unit according to the invention. Also, a tapered portion 62a is formed on the outer peripheral surface of the end portion of the inner pipe 10. The tapered portion 62a is progressively narrower toward the joint 2b. An annular rib 14 having a triangular cross section is projected from the outer peripheral surface of the end portion of the outer pipe 11. The annular rib 14 is arranged over the entire circumference of the outer peripheral surface of the end portion of the outer pipe 11. A tapered portion 62b is formed on the outer peripheral surface of the end portion of the outer pipe 11. The tapered portion 62b is progressively narrower toward the joint 2b.

The joint 2b is made of PA (polyamide) 66 in the

shape of a double bottomed cylinder. The joint 2b includes an inner peripheral chamber 20, an outer peripheral chamber 21, a first branch joint portion 22 and a second branch joint portion 23. The inner peripheral chamber 20 and the outer peripheral chamber 21 are defined by a cylindrical partitioning wall 24. The partitioning wall 24 is projected from the substantial center of the bottom wall 25 of the joint 2b. As a result, the inner peripheral chamber 20 and the outer peripheral chamber 21 are arranged substantially coaxially. Also, the end portion of the partitioning wall 24 is formed with a tapered portion 62c. The tapered portion 62c expands toward the heater pipe 1. The end portion of the inner pipe 10 is inserted in the end portion of the partitioning wall 24. The inner peripheral seal ring 60 is in elastic contact with the inner peripheral surface of the partitioning wall 24. This elastic contact secures the sealability between the inner pipe 10 and the inner peripheral chamber 20.

Two engaging hooks 260 are projected from the outer peripheral surface of the outer wall 26 of the joint 2b in 180-degree spaced relation with each other in peripheral direction. The engaging hooks 260 engage the annular rib 14. Due to this engagement, the heater pipe 1 and the joint 2b are connected by one action. A tapered portion 62d expanding toward the heater pipe 1 is formed at the end portion of the outer wall 26. An outer peripheral annular groove 261 is formed in the inner peripheral surface of the end portion of the outer wall 26. An outer peripheral rubber seal ring 61 is arranged in the outer peripheral annular groove 261. The outer peripheral seal ring 61 is included in the outer peripheral seal unit according to the invention. An end of the outer pipe 11 is inserted on the inner peripheral side of the outer peripheral seal ring 61. The outer peripheral seal ring 61 is in elastic contact with the outer peripheral surface of the outer pipe 11. This

elastic contact secures the sealability between the outer pipe 11 and the outer peripheral chamber 21.

The first branch joint portion 22 is cylindrical in shape and communicates with the inner peripheral chamber 20. The inner peripheral chamber 20 and the first branch joint portion 22 are arranged substantially linearly. The first branch joint portion 22 is press-fitted in the end portion of the heater hose 3g. The second branch joint portion 23 is cylindrical in shape and communicates with the outer peripheral chamber 21. The outer peripheral chamber 21 and the second branch joint portion 23 are arranged with an intersection angle of 90 degrees between the axial lines thereof. The second branch joint portion 23 is press-fitted into the end portion of the heater hose 3h.

The configuration of the joint 2a and the connecting portion thereof with the heater pipe 1 is similar to that of the joint 2b and the connecting portion thereof with the heater pipe 1, and therefore not explained.

Next, the flow of hot water according to this embodiment is explained. First, the flow of hot water between the engine 90 and the front heater 91 is explained. The hot water that has flowed out of the engine 90 flows into the front heater 91 through the heater hose 3a, the inflow pipe 4 and the heater hose 3b in that order. The hot water that has flowed into the front heater 91 heats the air-conditioning air. The hot water that has been deprived of heat by the air-conditioning air flows into the engine 90 again through the heater hose 3d, the outflow pipe 5 and the heater hose 3c, in that order. In this way, the hot water is circulating between the engine 90 and the front heater 91.

Next, the flow of hot water between the engine 90 and the rear heater 92 is explained. The hot water that has flowed out of the engine 90 flows into the rear heater 92 through the heater hose 3a, the inflow pipe 4,

the heater hose 3f, the inner peripheral chamber (not shown) of the joint 2a, the first branch joint portion (not shown) of the joint 2a, the inner pipe 10 of the heater pipe 1, the inner peripheral chamber 20 of the joint 2b, the first branch joint portion 22 of the joint 2b and the heater hose 3g, in that order. The hot water that has flowed into the rear heater 92 heats the air-conditioning air. The hot water that has been deprived of heat by the air-conditioning air flows into the engine 90 again through the heater hose 3h, the second branch joint portion 23 of the joint 2b, the outer peripheral chamber 21 of the joint 2b, the outer pipe 11 of the heater pipe 1, the outer peripheral chamber (not shown) of the joint 2a, the second branch joint portion (not shown) of the joint 2a, the heater hose 3e, the outflow pipe 5 and the heater hose 3c in that order. In this way, the hot water is circulating between the engine 90 and the rear heater 92.

Next, a method of assembling the heater pipe (pipe unit) 1 and the joints (joint unit) according to this embodiment is explained. Fig. 4 is an exploded perspective view showing the connecting portion between the rear heater-side end portion of the heater pipe and a joint. First, the inner peripheral seal ring 60 is arranged in the inner peripheral annular groove 12. At the same time, the outer peripheral seal ring 61 is arranged in the outer peripheral annular groove 261. Then, the engaging hook 260 and the annular rib 14 are rendered to engage each other. The first branch joint portion 22 is press-fitted into the heater hose 3g. At the same time, the second branch joint portion 23 is press-fitted into the heater hose 3h. In this way, the heater pipe 1 and the joint port 2b are assembled on each other.

Next, a method of producing a joint (joint unit) according to this embodiment is explained. The joint is produced by injection molding. Fig. 5 shows a layout of

a die used for molding a joint according to this embodiment. A die 7 includes a lower die 70, an upper die (not shown), a first slide die 71 and a second slide die 72. The upper die is symmetric with the lower die 70 and arranged above (in the upper part of the page) the lower die 70.

First, in the molding process, the die 7 is closed. PA66 resin in molten state is injected in the cavity of the die 7. The die 7 is held in a predetermined temperature pattern. In the process, the outer shape of the joint 2b is formed by the die surface of the upper die and the die surface of the lower die 70. At the same time, the inner shape of the joint 2b is formed by the die surface of the first slide die 71 and the die surface of the second slide die 72. Then, the die 7 is removed. First in removing the die, the upper die is moved upward. Then, the second slide die 72 is pulled out in axial direction of the second branch joint portion 23. The first slide die 71 is rotated by a predetermined angle and pulled out in axial direction of the partitioning wall 24. Before being pulled out, the first slide die 71 is rotated to prevent the first slide die 71 from interfering with the engaging hook 260 formed in the cavity. Finally, an outer peripheral annular groove 261 (indicated by one-dot chain in the drawing) is formed by grinding. In this way, the joint 2b according to this embodiment is produced. The joint 2a is also produced in similar fashion.

Next, an explanation is given about the effects of the heater pipe, the joint and the connecting structure between the heater pipe (pipe unit) and the joint (joint unit) according to this embodiment.

In the heater pipe 1 according to this embodiment, the inner pipe 10 on the inflow side of the heater is arranged in the outer pipe 11 on the outflow side of the heater. As compared with a case in which the heater pipe 100a on the inflow side of the heater and the heater pipe

100b on the outflow side of the heater are arranged independently of each other (Fig. 12), the energy loss of the hot water on the inflow side of the heater is smaller. In other words, the temperature of the hot water on the inflow side of the heater is reduced to a lesser degree.

Also, with the heater pipe 1 according to this embodiment, as compared with a case in which the heater pipe 100a on the inflow side of the heater and the heater pipe 100b on the outflow side of the heater are arranged independently of each other (Fig. 12), the installation space of the heater pipe 1 is smaller. As a result, the installation space of other members is less likely to be limited. Also, the freedom of the piping route is high, that is to say, the layout freedom is high.

With the heater pipe 1 according to this embodiment, the inner pipe 10 and the outer pipe 11 are arranged substantially coaxially. As a result, the effect of insulating the inner pipe 10 by the outer pipe 11 is substantially uniform over the entire circumference of the inner pipe 10.

With the joint 2b according to this embodiment, the inner peripheral chamber 20 and the outer peripheral chamber 21 of double pipe configuration can be rendered to branch and connect to the heater hoses 3g and 3h, respectively. Also, the installation space is smaller than in arranging different joints dedicated to the hot water inflow and the hot water outflow, respectively. This leads to a high layout freedom.

Also, with the joint 2b according to this embodiment, the inner peripheral chamber 20 and the first branch joint portion 22 are arranged substantially linearly. As a result, the flow path resistance between the inner peripheral chamber 20 and the first branch joint portion 22 is very small.

The joint 2a also has similar effects.

With the connecting structure between the heater

pipe (pipe unit) 1 and the joint (joint unit) 2b according to this embodiment, the heater pipe 1 and the joint 2b can be connected by one action by engaging the engaging hook 260 and the annular rib 14 each other. At the same time, the sealability between the inner pipe 10 and the inner peripheral chamber 20 can be secured by the inner seal ring 60. At the same time, the sealability is secured between the outer pipe 11 and the outer peripheral chamber 21 by the outer peripheral seal ring 61. As a result, the assembly work between the heater pipe and the joint is simplified. Also, in the case where the assembly work is conducted with the conventional spring-type hose clip, the heater pipe and the joint assembled together may be separated or the sealability between the heater pipe and the joint may be reduced due to an assembly error peculiar to workers. With the connecting structure between the heater pipe 1 and the joint 2b according to this embodiment, in contrast, the heater pipe 1 and the joint 2b are connected only by the engaging force of the annular rib 14 and the engaging hook 260. As a result, an assembly error peculiar to workers is less likely to occur. Specifically, a strong connecting force can be secured in stable fashion without regard to the difference of skill among workers. Thus, the connecting structure between the heater pipe 1 and the joint 2b according to this embodiment is advantageous in the case where a multiplicity of assembly points are involved.

In the connecting structure between the heater pipe (pipe unit) 1 and the joint (joint unit) 2b according to this embodiment, the inner peripheral chamber 20 and the outer peripheral chamber 21 are partitioned by the partitioning wall 24 integrated with the joint 2b. The partitioning wall 24 is fabricated integrally with the joint 2b by injection molding. For this reason, the partitioning wall 24 is strong. According to this embodiment, therefore, the inner peripheral chamber 20

and the outer peripheral chamber 21 can be positively insulated from each other. Also, the number of parts required is reduced compared with a case where the partitioning wall 24 and the joint 2b are formed independently of each other.

In the connecting structure between the heater pipe (pipe unit) 1 and the joint (joint unit) 2b according to this embodiment, the engaging hook 260 is formed integrally with the joint 2b by injection molding. As a result, both the number of parts and the number of assembly steps are reduced compared with a case in which the engaging hook 260 and the joint 2b are formed independently of each other.

In the connecting structure between the heater pipe (pipe unit) 1 and the joint (joint unit) 2b according to this embodiment, the engaging portion 260 and the annular rib 14 are arranged in such a position as not to reduce the sealing force of the outer peripheral seal ring 61 which otherwise might be reduced by engaging the engaging hook 260 and the annular rib 14 each other. Specifically, the root of the engaging hook 260 is arranged in axially predetermined spaced relation with the outer peripheral annular groove 261 (Fig. 2). Even in the case where the root of the engaging hook 260 is deformed under tension from the annular rib 14 due to the engaging force of the engaging hook 260 and the annular rib 14, therefore, the outer peripheral annular groove 261 is less liable to be deformed. Specifically, the elastic contacting force of the outer peripheral seal ring 61 with the bottom surface of the outer peripheral annular groove 261 and the outer peripheral surface of the outer pipe 11 is less likely to be reduced. As a result, the chance of the hot water leaking out is small.

In the connecting structure between the heater pipe (pipe unit) 1 and the joint (joint unit) 2b according to this embodiment, the engaging hook 260 is arranged as a joint-side engaging portion. Also, the annular rib 14 is

arranged as a pipe-side engaging portion. As a result, the heater pipe 1 and the joint 2b can be connected by one touch with a comparatively simple structure. Further, the annular rib 14 is arranged over the entire circumference along the outer peripheral surface of the outer pipe 11. Therefore, the engaging hook 260 can be freely engaged along the periphery of the annular rib 14. In other words, the joint 2b can be connected in a state twisted by an arbitrary angle in peripheral direction of the heater pipe 1. Thus, the first branch joint portion 22 and the second branch joint portion 23 of the joint 2b can be arranged at the desired angle. As a result, a high freedom of the piping route is realized, which in turn leads to a high layout freedom.

In the connecting structure between the heater pipe (pipe unit) 1 and the joint (joint unit) 2b according to this embodiment, a tapered portion 62a is formed at the end portion of the inner pipe 10, a tapered portion 62b at the end portion of the outer pipe 11, a tapered portion 62c at the end portion of the partitioning wall 24, and a tapered portion 62d at the end portion of the outer wall 26. The tapered portions 62a, 62b of the inner pipe 10 and the outer pipe 11 make up inserting members and are progressively narrower toward the partitioning wall 24 and the outer wall 26 constituting receiving members. On the contrary, the tapered portions 62c, 62d of the partitioning wall 24 and the outer wall 26 constitute the receiving members and expand toward the inner pipe 10 and the outer pipe 11 constituting the inserting members. According to this embodiment, therefore, the inner pipe 10 can be inserted easily into the partitioning wall 24, and so can the outer pipe 11 into the outer wall 26. In other words, the joint 2b and the heating pipe 1 are easily set in relative positions to each other.

The connecting structure between the heater pipe (pipe unit) 1 and the joint (joint unit) 2a also has

similar effects.

(Second embodiment)

The difference between the second embodiment and the first embodiment lies in that, according to the second embodiment, the outer peripheral chamber of the joint and the second branch joint portion are arranged with an intersection angle of more than 90 degrees between axial lines thereof. Only this difference is explained below.

Fig. 6 is an axial sectional view showing the connecting portion between the rear heater-side end portion of the heater pipe (pipe unit) 1 and the joint (joint unit) 2b. In Fig. 6, the component parts corresponding to those in Fig. 2 are designated by the same reference numerals, respectively. As shown in Fig. 6, the outer peripheral chamber 21 and the second branch joint portion 23 are arranged with an intersection angle of about 135 degrees between the axial lines thereof.

The heater pipe, the joint and the connecting structure between the heater pipe (pipe unit) and the joint (joint unit) according to this embodiment have a similar effect to those of the first embodiment. Also, with the joint 2b according to this embodiment, the flow path resistance is reduced between the outer peripheral chamber 21 and the second branch joint portion 23.

(Third embodiment)

The difference between this embodiment and the first embodiment resides in that according to this embodiment, the first branch joint portion and the second branch joint portion are arranged substantially in parallel to the joint axis. This difference alone is explained below.

Fig. 7 is an axial sectional view showing the connecting portion between the rear heater side end portion between the heater pipe (pipe unit) 1 and the joint (joint unit) 2b. In Fig. 7, the component parts corresponding to those in Fig. 2 are designated by the same reference numerals, respectively. As shown in Fig.

7, the first branch joint portion 22 and the second branch joint portion 23 are arranged substantially in parallel to the axis of the joint 2b.

The heater pipe, the joint and the connecting structure between the heater pipe (pipe unit) and the joint (joint unit) according to this embodiment have a similar effect to those of the first embodiment. With the joint 2b according to this embodiment, the radial projection margin of the first branch joint portion 22 and the second branch joint portion 23 is eliminated, thereby leading to a compact structure. Also, according to this embodiment, the axial direction of the joint 2b coincides with the longitudinal direction of the vehicle. As a result, the first branch joint portion 22 and the second branch joint portion 23 are kept out of contact with the air flow while the vehicle is running. Thus, the temperature drop of the hot water, due to the air flow, is suppressed.

(Fourth embodiment)

This embodiment is different from the first embodiment in the lack of the rear heater, and the heater pipe (pipe unit) and the joint (joint unit) are interposed between the engine and the front heater. This difference alone is explained below.

Fig. 8 shows a layout of the heater pipe (pipe unit) and the joints (joint unit) according to this embodiment. In Fig. 8, the component parts corresponding to those of Fig. 1 are designated by the same reference numerals, respectively. As shown in Fig. 8, the heater pipe 1 and the joints 2a, 2b are interposed between the engine 90 and the front heater 91. Specifically, the joint 2a connects the heater pipe 1 and the heater hoses 3a, 3c as branches. The joint 2b, on the other hand, connects the heater pipe 1 and the heater hoses 3b, 3d as branches.

The hot water that has flowed out of the engine 90 flows into the front heater 91 through the heater hose 3a, the inner peripheral chamber (not shown) of the joint

2a, the first branch joint portion (not shown) of the joint 2a, the inner pipe 10 of the heater pipe 1, the inner peripheral chamber (not shown) of the joint 2b, the first branch joint portion (not shown) of the joint 2b and the heater hose 3b, in that order. The hot water that has flowed into the front heater 91 heats the air-conditioning air. The hot air deprived of heat by the air-conditioning air flows into the engine 90 again through the heater hose 3d, the second branch joint portion (not shown) of the joint 2b, the outer peripheral chamber (not shown) of the joint 2b, the outer pipe 11 of the heater pipe 1, the outer peripheral chamber (not shown) of the joint 2a, the second branch joint portion (not shown) of the joint 2a and the heater hose 3c, in that order. In this way, the hot water circulates between the engine 90 and the front heater 91.

According to this embodiment, the temperature drop of the hot water supplied to the front heater 91 is suppressed. Also, the layout freedom is improved between the engine 90 and the front heater 91.

(Fifth embodiment)

The differences between the fifth embodiment and the first embodiment are that no partitioning wall is formed in the joint (joint unit), that the inner peripheral chamber and the outer peripheral chamber are insulated from each other by the inner pipe, and that the inner peripheral seal ring and the outer peripheral seal ring are held in axial direction. These differences alone are explained below.

Fig. 9 is an axial sectional view showing the connecting portion between the rear heater-side end portion of the heater pipe (pipe unit) and a joint (joint unit). Fig. 10 is an axially exploded sectional view showing the connecting portion between the rear heater-side end portion of the heater pipe (pipe unit) and a joint (joint unit). In Fig. 9, the component parts corresponding to those of Fig. 2 are designated by the

same reference numerals, respectively. As shown in Fig. 9, the inner peripheral chamber 20 and the outer peripheral chamber 21 are shut off from each other by the inner pipe 10 instead of by the partitioning wall.

An outer pipe flange 15 is formed at the root of the annular rib 14 of the outer pipe 11. In a similar fashion, an inner pipe flange 16 is formed on the outer peripheral surface of the end portion of the inner pipe 10. On the other hand, the end portion of the outer wall 26 is formed with an outer wall stepped portion 262. In similar fashion, the inner surface of the bottom wall 25 is formed with a bottom wall stepped portion 250. The outer peripheral seal ring 61 is held axially between the outer pipe flange 15 and the outer wall stepped portion 262 by the engaging force of the engaging hook 260 and the annular rib 14. In similar fashion, the inner peripheral seal ring 60 is held axially between the inner pipe flange 16 and the bottom wall stepped portion 250 by the engaging force of the engaging hook 260 and the annular rib 14.

In assembling the heater pipe (pipe unit) and a joint (joint unit), first of all, the outer peripheral seal ring 61 is arranged on the outer pipe flange 15. At the same time, the inner peripheral seal ring 60 is arranged on the inner pipe flange 16. Then, the engaging hook 260 and the annular rib 14 are caused to engage each other.

In molding the joint (joint unit), a die shown in Fig. 11 is used. In Fig. 11, the component parts corresponding to those shown in Fig. 5 are designated by the same reference numerals, respectively. The die 7 includes a lower die 70, an upper die (not shown), a first slide die 71 and a second slide die 72. The upper die is symmetric with the lower die 70, and arranged above (in the upper part of the page) the lower die 70.

In molding the joint, the first step is to close the die 7. Then, molten PA66 resin is injected into the

cavity of the die 7. The die 7 is held in a predetermined temperature pattern. In the process, the outer surface shape of the joint 2b is formed by the die surfaces of the upper die and the lower die 70. Also, the inner surface shape of the joint 2b is formed by the die surfaces of the first slide die 71 and the second slide die 72. Then, the die 7 is removed. In removing the die, the first step is to move the upper die upward. Then, the second slide die 72 is axially pulled out of the second branch joint portion 23. The first slide die 71 is rotated by a predetermined angle and pulled out along the axial direction of the outer wall 26. The first slide die 71 is rotated before being pulled out to prevent the first slide die 71 from interfering with the engaging hook 260 formed in the cavity. In this way, the joint 2b according to this embodiment is produced.

The heater pipe, the joints and the connecting structure between the heater pipe (pipe unit) and the joints (joint unit) according to this embodiment have a similar effect to the corresponding parts of the first embodiment. The joint 2b according to this embodiment has no partitioning wall. As a result, the internal shape of the joint 2b is simplified, thereby facilitating the molding, while at the same time simplifying the shape of the first slide die 71 used for molding. Also, the inner peripheral seal ring 60 and the outer peripheral seal ring 61 according to this embodiment are held axially between the heater pipe 1 and the joint 2b by the engaging force of the engaging hook 260 and the annular rib 14. As a result, there is no need to provide the outer peripheral annular groove 261 on the joint 2b (Fig. 2). In this respect, too, the joint 2b is easily fabricated. Also, the inner pipe 10 according to this embodiment requires no inner peripheral annular groove 12 (Fig. 2). As a result, the inner diameter of the inner pipe 10 is not reduced by the inner peripheral annular groove 12. In other words, the cross sectional area of

the hot water flow path in the inner pipe 10 is not reduced. Therefore, the hot water flow rate required to heat the air-conditioning air can be secured with comparative ease.

The heater pipe, the joints and the connecting structure between the heater pipe (pipe unit) and the joints (joint unit) according to embodiments of the invention are explained above. The invention, however, is not specifically limited to the embodiments having the configuration described above. Instead, the invention is applicable to various modifications and improvements conceivable by those skilled in the art.

In the embodiments described above, instead of the annular rib 14 used as a pipe-side engaging portion, a depression adapted to engage the engaging hook 260 may be arranged on the outer peripheral surface of the outer pipe 11. Also, in the embodiments described above, the inner peripheral seal ring 60 (inner peripheral seal unit) and the outer peripheral seal ring 61 (outer peripheral seal unit) are arranged independently of the heater pipe 1 and the joint 2b. Nevertheless, the inner peripheral seal unit and the outer peripheral seal unit may be arranged integrally with one of the heater pipe 1 and the joint 2b. In the first embodiment, for example, a lip in elastic contact with the outer peripheral surface of the outer pipe 11 is formed from the inner peripheral surface of the outer wall 26, and a lip in elastic contact with the outer peripheral surface of the inner pipe 10 is formed from the inner peripheral surface of the partitioning wall 24, as an outer peripheral seal unit and an inner peripheral seal unit, respectively. In this way, the number of parts required is reduced. Also, in the embodiments described above, the heater pipe 1 may be made of steel or resin instead of aluminum. Further, in the embodiments described above, the tapered portions 62a, 62b, 62c, 62d which are chamfered may alternatively be formed as a conical surfaces.

It will thus be understood from the foregoing description that according to this invention, a heater pipe is provided which suppresses the temperature drop of the hot water on the inflow side of each heater. Also, a joint high in layout freedom is provided. Further, there is provided a connecting structure high in assembly workability between the heater pipe and the joints.